# 8.15 Geologic Hazards and Resources

## 8.15.1 Introduction

This section evaluates the effect of geologic hazards and resources that might be encountered on the project site. The objective of this evaluation is to identify site conditions and the potential impacts from the construction or operation of the project. This section presents a summary of the relevant laws, ordinances, regulations, and standards (LORS); the existing site conditions; and the expected direct, indirect, and cumulative impacts due to construction, operation, and maintenance of the project. Proposed mitigation measures and the effectiveness and monitoring plans are also described. Permits that are required and permitting agencies are identified.

## 8.15.2 Laws, Ordinances, Regulations, and Standards

The LORS that apply to geologic resources and hazards are summarized in Table 8.15-1.

**TABLE 8.15-1**
Laws, Ordinances, Regulations, and Standards

| Jurisdiction | Authority | Administering Agency | Compliance |
|---|---|---|---|
| State/Local | Uniform Building Code (UBC), 1997. Appendix Chapter 16, Division 4.<br>California Building Code (CBC), 1998. | City of Turlock Building Department | Acceptable design criteria for structures with respect to seismic design and load-bearing capacity. |

## 8.15.3 Affected Environment

The proposed Turlock Irrigation District (TID) Walnut Energy Center (WEC) site is an 18-acre parcel within the western boundary of the City of Turlock, California. The project site and linears are located along the eastern flank of the Great Valley geomorphic province and near the western edge of the Sierra Nevada geomorphic province. The proposed generating facility site is relatively flat (approximate elevation 80 feet) and is underlain by thick Quaternary and Tertiary alluvial deposits that originated from the erosion of the Sierra Nevada. Although the mountainous areas to the east and west are seismically active, the Central Valley is considered to be generally seismically stable and is designated as a California UBC Seismic Zone 3 (Condor 2002).

### 8.15.3.1 Regional Geology

Turlock is located in the central part of the Great Valley geomorphic province. The Great Valley is an approximate 400-mile long northwest-southeast trending deep structural basin that extends along the center of the state from the Tehachapi Mountains in the south to the Klamath Mountains in the north (Norris and Webb 1990). The Sierra Nevada geomorphic province is characterized as a north-northwest trending mountain range sloping gently west to the Central Valley that comprises Jurassic to Cretaceous plutonic (chiefly granitic) rocks (Norris and Webb 1990). The structural trough in bedrock formations between the ranges was filled with alluvial, lacustrine, and marine deposits of Cretaceous, Tertiary, and Quaternary age. Deposits up to 30,000 feet are present near the western edge of the valley and dip relatively uniformly from each side of the valley toward its axis.

### 8.15.3.2 Local Geology

The project site and linears are located in an area of fairly flat topography (elevation approximately 80 feet above mean sea level) in the northern part of the San Joaquin Valley. The project site is underlain by five major geologic units. These units include metamorphic and igneous basement complex, consolidated marine deposits, consolidated volcanic rocks, continental deposits, and unconsolidated older alluvium. Near-surface deposits consist of thick Quaternary alluvial fan and river flood plain deposits derived from fluvial systems originating from higher elevations to the east. Depth to water at the site has been measured by others to be approximately 4 to 6 feet below ground surface after a significant storm event (Condor 2002). However, the groundwater level quickly recedes. Typical water levels are 8-12 feet below the surface. Figure 8.15-1 (figures are located at the end of the section) shows the stratigraphic units, strata, and geographic features within a 2-mile radius of the WEC project site.

### 8.15.3.3 Stratigraphy

The younger geologic units are those that affect the site most directly. These units include recent river channel and flood plain deposits and the older Quaternary Modesto, Riverbank, and Turlock Lake Formations. Below the Turlock Lake Formation is the Tertiary Mehrten Formation. These are discussed in further detail below (Wagner et al. 1990). A generalized geologic cross section beneath the project site is shown on Figure 8.15-2.

**Recent Deposits.** River channel and flood plain deposits come from local sources. Thickness ranges from 0 to 50 feet.

**Quaternary Modesto Formation.** Alluvial fan deposits from the Sierra Nevada include the Modesto Formation, which typically consists of discontinuous, lenticular clay and silt lenses interbedded with sand-rich sediments. Thickness ranges from 50 to 100 feet.

**Quaternary Riverbank Formation.** Alluvial fan deposits from the Sierra Nevada include the Riverbank Formation and consist of deposits similar to the Modesto Formation, but also contain a regional clay layer referred to as the Corcoran clay. The Corcoran clay (also known as the E-Clay or Blue Clay) has been mapped over a large area of the San Joaquin Valley and is the thickest and most widespread clay layer. The Corcoran clay acts as an aquitard between the overlying unconfined aquifer and the underlying confined aquifer. Thickness ranges from 150 to 200 feet.

**Quaternary Turlock Lake Formation.** Sandstone, siltstone, and conglomerate are derived mainly from Sierran granitic and metamorphic source rocks; non-marine. May also contain the Corcoran clay. Thickness ranges from 350 to 850 feet.

**Tertiary Mehrten Formation.** Consolidated non-marine agglomerate, conglomerate, tuffaceous sandstone and siltstone—derived from andesitic sources comprise the Mehrten Formation. This material also contains some andesite mudflow breccia (lahar). Thickness ranges from 800 to 1,200 feet.

### 8.15.3.4 Structure

The structural geology of the area is not complex. No major deformation-associated historic tectonic activity is present. No faults or landslides are within the local area.

### 8.15.3.5 Seismicity

The Turlock area is not an area of major fault activity. The Central Valley of California is considered to be an area of relatively low seismicity. During the formation of the Coast Ranges and the Sierra Nevada, numerous faults and shear zones developed. These faults are primarily in the foothills of the Sierra Nevada Mountains and in the Coast Ranges. A few faults extend beneath the valley sediments. The nearest fault to the site is the San Joaquin Fault, which is a northwest-southeast trending fault approximately 15 miles to the west. The Vernalis Fault lies approximately 25 miles northwest of the project. The Ortigalita Fault lies approximately 25 miles southwest. All of these faults are considered active and are shown on Figure 8.15-3. East of the site, numerous faults associated with the Sierra Nevada block are present, but are more than 30 miles from the project site. No activity within recent time has occurred on these fault zones. The site is not located within a special study zone, as delineated by the Alquist-Priolo Special Studies Zone Act of 1972; and no known fault, active or inactive, reaches the surface within Turlock (Jennings 1994).

The nearest fault system east of the project site is part of the Foothills fault system containing the Bear Mountain fault zone. This area is approximately 35 miles east of the site. This faults system was considered inactive until 1975 when a Richter magnitude 5.7 earthquake occurred near Oroville in far northern California. Subsequent to this event, the Foothills fault system was re-evaluated from inactive to having a potential Richter magnitude of 6.5 anywhere along its trace.

The major faults that have historically produced earthquakes of the greatest magnitude in central California are the Calaveras, Hayward, and San Andreas faults in the Coast Ranges; the Greenville and Midland faults on the west side of the Great Valley, and the Sierra Nevada and Owens Valley faults east of the Sierra Nevada mountains. These principal faults could affect the project site and their respective maximum credible and probable earthquakes are presented in Table 8.15-2 (Mualchin 1996).

**TABLE 8.15-2**
Principal Faults in the Site Region

| | | Maximum Credible Earthquake | | Maximum Probable Earthquake | |
|---|---|---|---|---|---|
| **Fault Name** | **Distance from Site (miles)** | **Magnitude (Mw)** | **Peak Site Acceleration (g)** | **Magnitude (Mw)** | **Peak Site Acceleration (g)** |
| Calaveras | 45 | 7.5 | 0.10 | 7.0 | 0.07 |
| Greenville | 35 | 7.0 | 0.11 | 5.25 | 0.03 |
| Hayward | 60 | 7.5 | 0.10 | 7.0 | 0.07 |
| San Andreas | 55 | 8.5 | 0.22 | 8.25 | 0.18 |
| Foothills (Bear Mountains | 35 | 6.5 | 0.09 | — | — |

Mw = Moment magnitude
g = 9.8 meters squared per second

The nearest known active faults are those located well west of the site and include the San Andreas, Calaveras, and the Hayward—all of which have maximum credible earthquakes (MCEs) greater than Richter magnitude 7.5 (Mualchin 1996). However, given the distance of these faults from the project site (45+ miles) the effect of an earthquake along these faults to the project site would likely be minimal.

### 8.15.3.6 Geologic Hazards

A geotechnical investigation was previously conducted for TID at the intersection of Tidewater Southern railroad and Washington Road by Condor Earth Technologies (Condor) in July 2001. The scope of this investigation was to assess soil conditions, depth to groundwater, and anticipated foundation loads for the proposed power plant and supplemented the July 2000 report. The July 2000 investigation provided engineering recommendations for substation structures.

A site-specific geotechnical investigation is planned to be conducted at the project site during late October 2002. Site-specific information will be incorporated when available.

The following subsections discuss the potential geologic hazards that might occur in the project area.

**Ground Rupture**. Ground rupture is caused when an earthquake event along a fault creates rupture at the surface. Since no known faults exist at the project site, the likelihood of ground rupture to occur at the project site is low.

**Seismic Shaking.** The most significant geologic hazard at the WEC site is strong ground-shaking due to an earthquake. Mualchin (1996) estimated that the ground-shaking of a magnitude 7 earthquake along the Foothills fault system could produce peak ground gravity (g) acceleration of up to 0.2 g in the vicinity of the WEC.

**Liquefaction.** During strong ground-shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength. This phenomenon is known as liquefaction. Liquefaction is dependent on grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement. The depth to groundwater at the project site is very shallow, approximately 5 feet, and the soil types generally consist of silts and silty sands (Condor 2002); therefore, the likelihood that liquefaction will occur is considered moderate.

**Mass Wasting.** Mass wasting depends on steepness of the slope, underlying geology, surface soil strength, and moisture in the soil. Significant excavating, grading, or fill work during construction might introduce mass wasting hazards at either the WEC site or along linear facility routes. Because the WEC site is flat and no significant excavation is planned during site construction, the potential for direct impact from mass wasting at the site is considered low.

**Subsidence.** Subsidence can be a natural or man-made phenomenon resulting from tectonic movement, consolidation, hydrocompaction, or rapid sedimentation. Stanislaus County has experienced some regional subsidence, primarily on the western side of the county. This subsidence has resulted from long-term withdrawal of groundwater causing compaction of fine-grained sediments in the aquifer system. The potential for subsidence as a hazard that could affect the project site is low to moderate.

**Expansive Soils.** Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. Site-specific borings advanced in the vicinity of the project site have identified primarily silts and silty sands and minor clays and are generally medium-dense to dense (Condor 2002). In addition, the depth to water is shallow and significant shrink-swelling would not be expected. Based on these, the likelihood of expansive soils to be present at the site is low.

**Geologic Resources of Recreational, Commercial, or Scientific Value.** Geologic resources of recreational, commercial, or scientific value in the project vicinity that could be affected include aggregate and gas reserves. Geologic resources of value were identified from the Stanislaus County Plan (Stanislaus County 2000) and include aggregate resources, discussed in the next paragraph.

**Aggregate Resources.** There are several aggregate resources in the County, none of which are currently mined or identified in the project vicinity. The nearest location of aggregate production occurs west of Interstate 5 (Stanislaus County 2000), approximately 20 miles to the west. The project could utilize this resource for construction.

**Natural Gas.** No oil or gas fields are present in the project vicinity, according to on-line maps from the State of California Division of Oil, Gas and Geothermal Resources (CDOGGR 2002).

There are no known geologic resources that provide a significant scientific or recreational value in the vicinity of the site.

## 8.15.4 Environmental Impacts

### 8.15.4.1 Generating Facility

**Geologic Hazards.** Ground-shaking presents the most significant geologic hazard to the proposed WEC and linear facilities. Table 8.15-3 summarizes the geologic hazards associated with the WEC site and linear facilities.

**TABLE 8.15-3**
Summary of Potential Geologic Hazards

| Project Component | Area of Potential Concern | Geologic Hazards of Potential Concern |
|---|---|---|
| Proposed Generating Facility Site (up to 15 Acres) | Entire site | Seismic ground-shaking |
| Proposed Linear Facilities | Entire site | Seismic ground-shaking |

**Geologic Conditions and Topography.** Construction will require minor grading and excavation, thereby altering the terrain of the WEC site. Impacts on the geologic conditions involve changes in drainage, cuts, and fills. Since the site is generally level, site grading is not expected to adversely impact the geologic environment.

### 8.15.4.2 Linear Facilities

Linear facilities associated with the WEC site include a natural gas line, potable water line, transmission lines, and recycled water line discussed below. The geologic hazards associated with the linear facility are summarized in Table 8.15-3.

Seismically induced ground-shaking presents a possible hazard to the proposed linear facilities. This hazard could cause pipeline rupture. With implementation of the mitigation measures proposed in subsection 8.15.5, the hazards will be reduced to less than significant.

### 8.15.4.3 Geologic Resources of Recreational, Commercial, and Scientific Value

Aggregate production is a major resource of Stanislaus County that may potentially be affected by the project. Construction and operation of the WEC site would not significantly affect this resource. Also, there are no known geologic resources that provide a significant scientific or recreational value in the vicinity of the site. Therefore, the WEC project would not affect these resources.

## 8.15.5 Mitigation Measures

The following subsections describe mitigation measures that could be used to reduce impacts from geologic hazards.

### 8.15.5.1 Ground Rupture

No active faults cross the WEC site or any of the linear facility corridors (Jennings 1994). Therefore, no mitigation measures are required to reduce the hazard from surface faulting rupture.

### 8.15.5.2 Ground-Shaking

The WEC generating facility and linear facilities will need to be designed and constructed to withstand strong earthquake-shaking as specified in the 1998 California Building Code (CBC) for Seismic Zone 3.

### 8.15.5.3 Liquefaction

The soil types present at the WEC site may be conducive to liquefaction. A geotechnical investigation, by Condor Earth Technologies, performed at the project site did not specifically address liquefaction potential.

### 8.15.5.4 Subsidence

Subsidence has occurred regionally in the County – primarily in the western part. Subsidence has not been identified to have occurred in the project vicinity, and as a result, no mitigation measures would be required.

### 8.15.5.5 Expansive Soils

Expansive soils can be mitigated by either removing the soil and backfilling with non-expansive soil, instituting a chemical stabilization of the soil, or by constructing a foundation treatment that resists uplift of the expansive soil. The site-specific geotechnical investigation did not identify soils that would be prone to expansion. As a result, mitigation measures would not be required at the site.

## 8.15.6 Involved Agencies and Agency Contacts

No permits are required for compliance with geological LORS. However, the City of Turlock Building Department is responsible for enforcing compliance to building standards (City of Turlock 2002).

## 8.15.7 Permits Required and Permit Schedule

Compliance of building construction to UBC standards is covered under engineering and construction permits for the project. There are no other permit requirement that specifically address geologic resources and hazards.

## 8.15.8 References

California Division of Mines and Geology. 1999. Alquist-Priolo Zone Maps Index. Information obtained from the DMG website at: http://www.consrv.ca.gov/dmg/rghm/a-p/mapidx/index.htm.

California Division of Oil, Gas, and Geothermal Resources (CDOGGR). 2002. Oil and Gas Field Maps. http://www.consrv.ca.gov/dog/maps/index_map.htm.

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Stanislaus County. 2000. Stanislaus County General Plan. June.

Wagner, D.L., E.J. Bortugno, and R.D. McJunkin. 1990. Geologic Map of the San Francisco-San Jose Quadrangle, California. California Division of Mines and Geology, Regional Geologic Map Series, 1:250,000 scale.

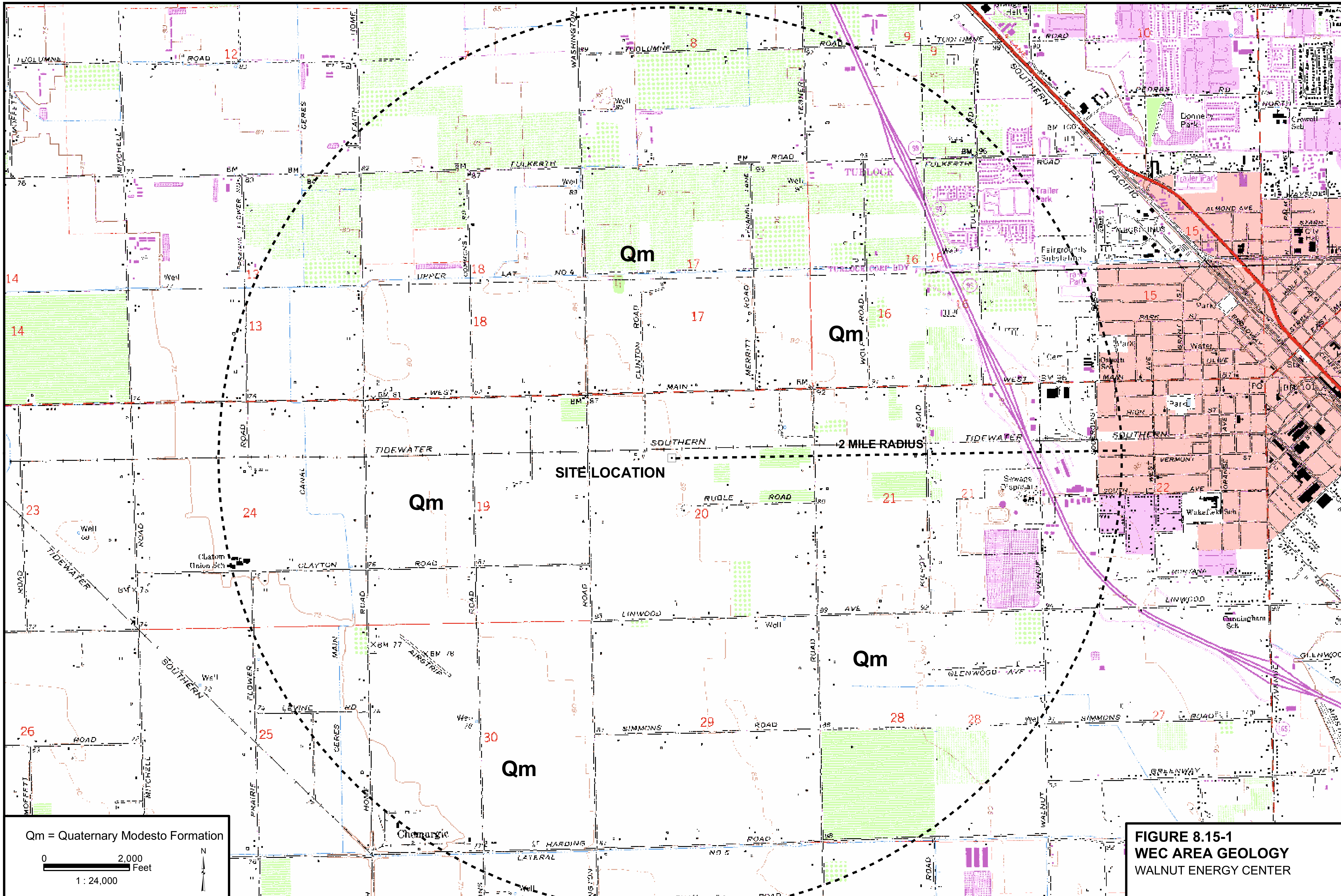


**FIGURE 8.15-1**
**WEC AREA GEOLOGY**
WALNUT ENERGY CENTER

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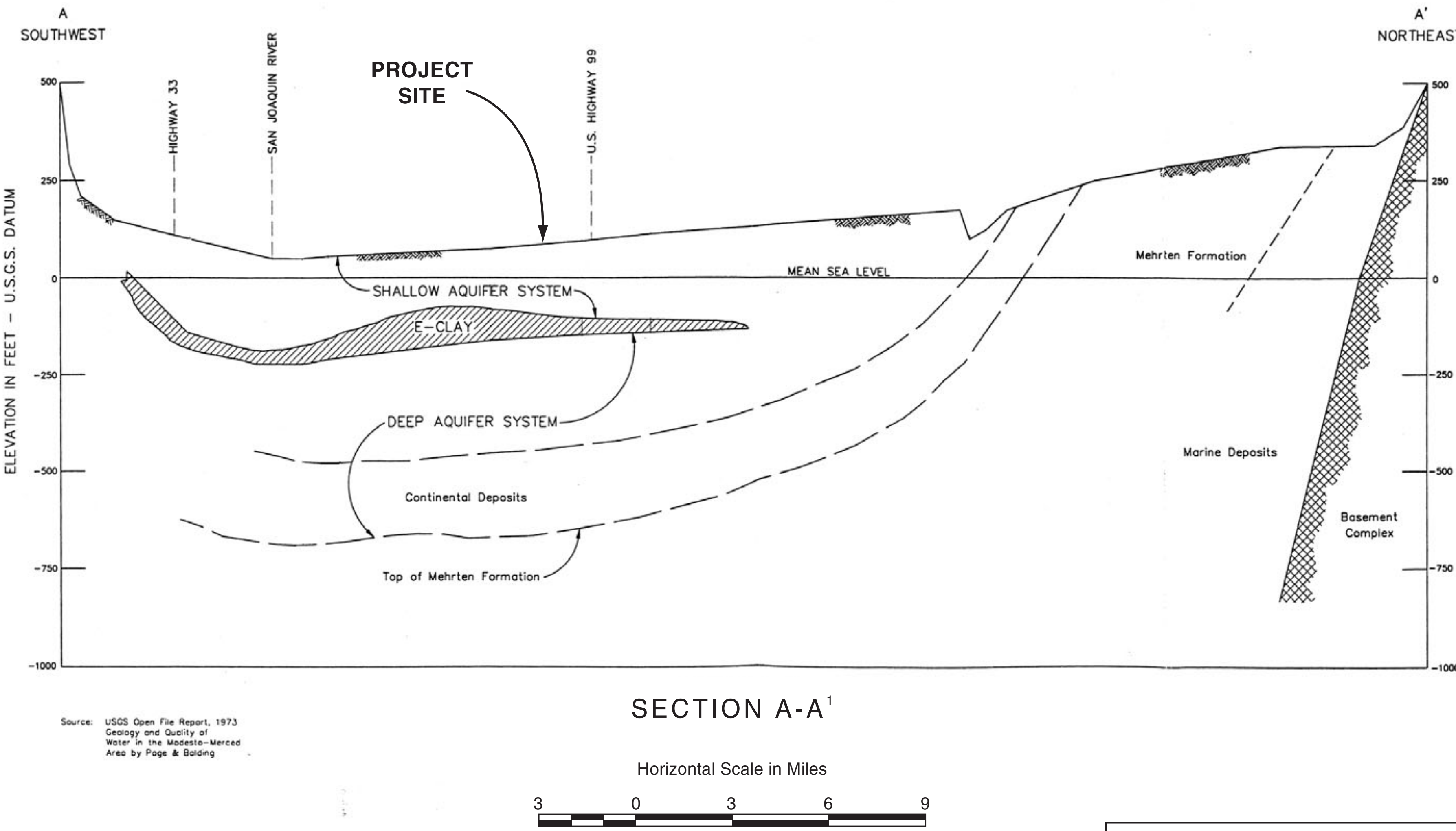


**FIGURE 8.15-2**
**GENERALIZED GEOLOGIC CROSS-SECTION**
WALNUT ENERGY CENTER

CH2MHILL

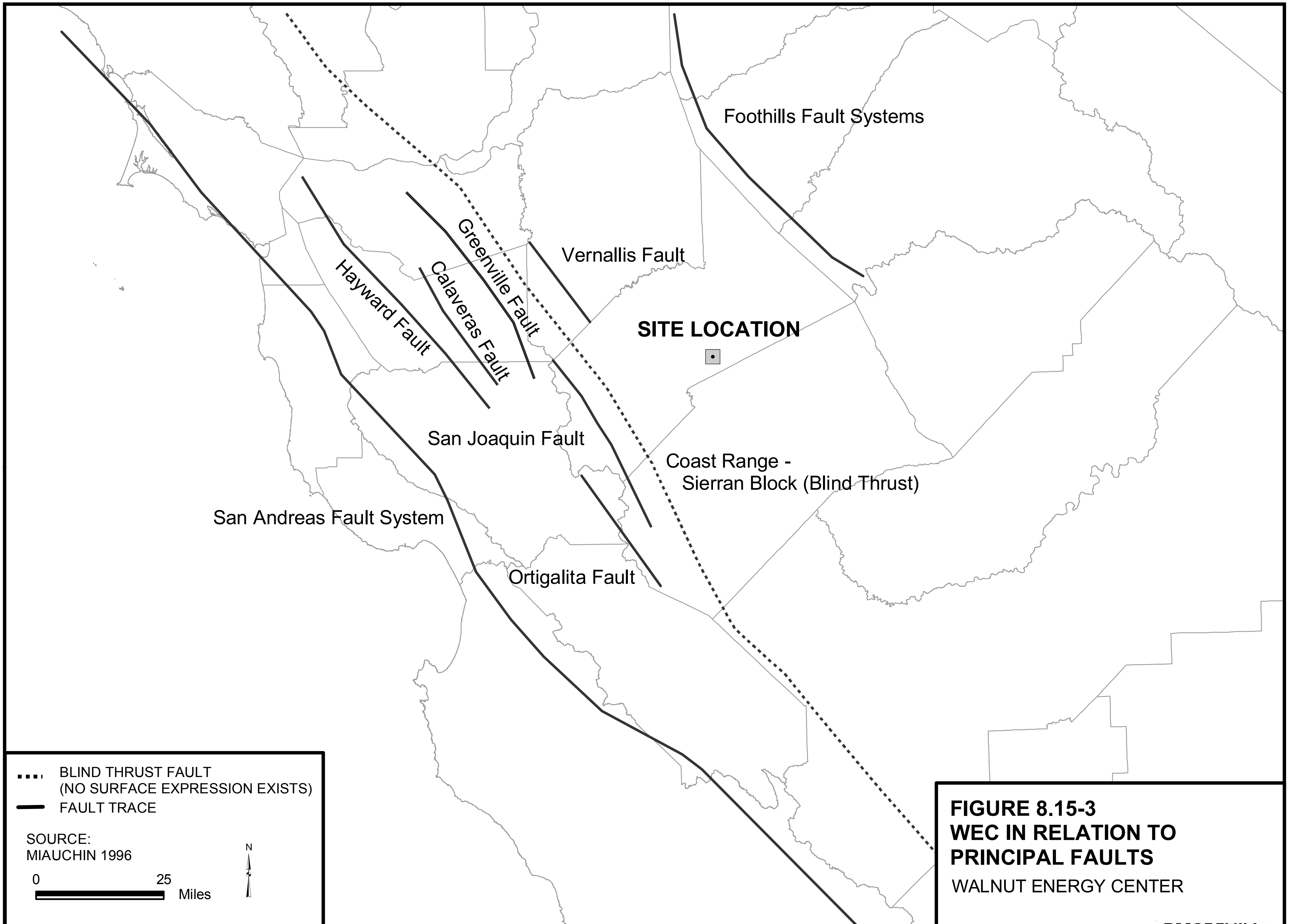


**FIGURE 8.15-3**
**WEC IN RELATION TO PRINCIPAL FAULTS**
WALNUT ENERGY CENTER

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